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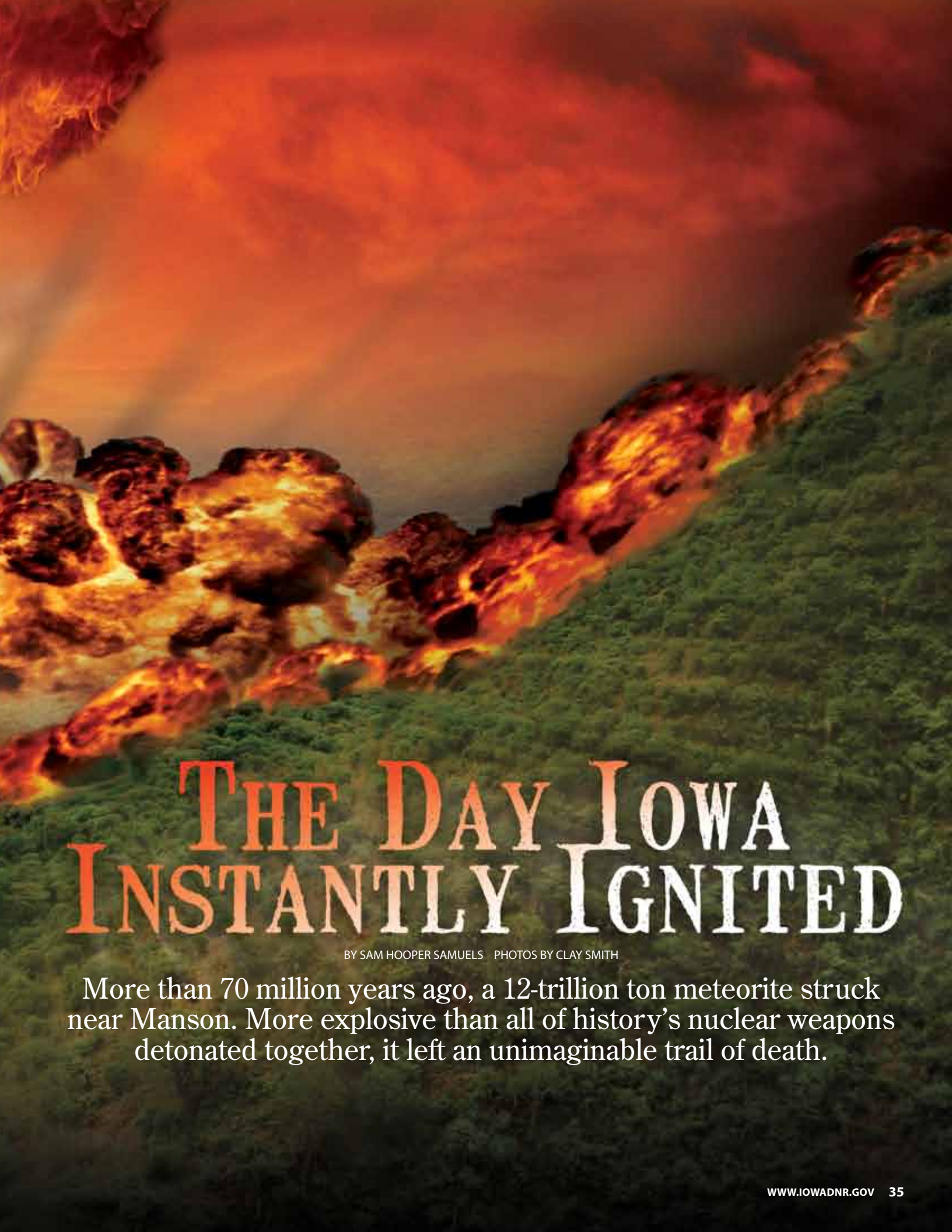

The Day Iowa Instantly Ignited

BY SAM HOOPER SAMUELS PHOTOS BY CLAY SMITH

More than 70 million years ago, a 12-trillion ton meteorite struck near Manson. More explosive than all of history's nuclear weapons detonated together, it left an unimaginable trail of death.

1) Writer Sam Samuels looks through a hand lens at a core sample from the impact site. 2) Core samples of rocks altered by the impact force. The boxed slab on the left was almost completely melted, with the dark area glass and recrystallized feldspar grains appearing light gray. Specimens on each side of the circular core show bits of broken, or brecciated, rock torn apart from the impact shock wave. The circle-shaped core is mostly white—formed as intense heat turned rock to glass. 3) Held core sample shows granitic rocks, once buried thousands of feet down, then brecciated, mixed and lifted to near-surface by the impact. 4-6) Along Lizard Creek in Webster County, Ray Anderson examines Cretaceous shales near the outer limit of the crater. The shale itself was little changed by the impact energy. Easily eroded, the shale exists a part of one of many large blocks of rock layer that sank down inside the crater. Similar rock outside the crater area eroded away thousands of years earlier. 7) Just outside crater limit, Ray stands in a limestone quarry near Gilmore City, an important geological resource in the area.


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I'm standing in a rock library, or "core shed" as the geologists call them, at the University of Iowa's Oakdale Research Park in Coralville with Ray Anderson of the Iowa Geological Survey. A core shed looks less like a library than a hardware store. The aisles are constructed of rough wood in a warehouse-like ambience, with fork lifts and canvas bags of rocks here and there on the cement floor. The shelves are stacked not with books, but with cardboard boxes full of rock samples, all marked with cryptic codes denoting where they were drilled and from what depth. Anderson, a geologist with a thick sandy-red beard, a mane of curly hair, and a special interest in meteorites, is trying to retrieve a box of longitudinally-sawed core samples of Phanerozoic clast breccia he extracted in Calhoun County near Manson a few years back, which he really wants me to see.

"Shoot, I was going to show you the M-1 cores," Anderson says as he looks at the unstable pile of lumber someone has decided to store in the aisle between us and the sought-after rock samples. "There's lots to see, if I can get to it." He clambers in, his large frame teetering on loose boards, and finds the box he wants. That's when I notice a small cylindrical yellow object hanging from his neck by a leather lanyard.

"That's my Kennecott copper magnet," Anderson says, showing me the flat metal tip. If you're a bank, you give customers a nice pen with your company's name on it, or perhaps a travel mug. If you're an international mining company like Kennecott Exploration, you give out magnets.

"Folks bring in what they think are meteorites all the time," he says. But most true meteorites contain lots of iron, while most ordinary stones do not. "This is to see if it's magnetic."

OK, I think, this really is a meteorite expert. He may not have a pencil on him, but he is never without his meteorite-testing magnet.

"I know more about the Manson Crater than anyone alive or dead," Anderson tells me. I believe him.

The Manson Crater, or more correctly the Manson Impact Structure, is what I've come to find. It is the remains of a mountain-sized meteorite that plowed into the ground in nortwest Iowa near Manson, about 74 million years ago. Most meteors start out as asteroids, small rocks floating in space within our solar system that never quite came together to become a planet but that orbit the sun in a messy band between Mars and Jupiter. Occasionally, one is yanked out of orbit by the tremendous force of Jupiter's gravitational field. Some become "Earth-crossing asteroids," their erratic paths crossing the Earth's orbit. Some of those actually fall to Earth and become meteors.

Most of those never make it to the ground. They burn up in the atmosphere as falling stars, fleeting streaks of light that glow and die in the sky. The few that do make it through the atmosphere are dubbed meteorites. Most of these are fairly small, and they induce a strange, almost cultish fascination among geologists and collectors.

Meteorites are the oldest dated materials in the solar system, about 4.5 billion years old, making them nearly a billion years older than the oldest rocks on Earth. There is something about holding in your hands this ancient object that fell from outer space that induces awe and covetousness. A small slice sawed from a well-documented meteorite may cost $100 to collectors.

Eight are known to have landed in Iowa.

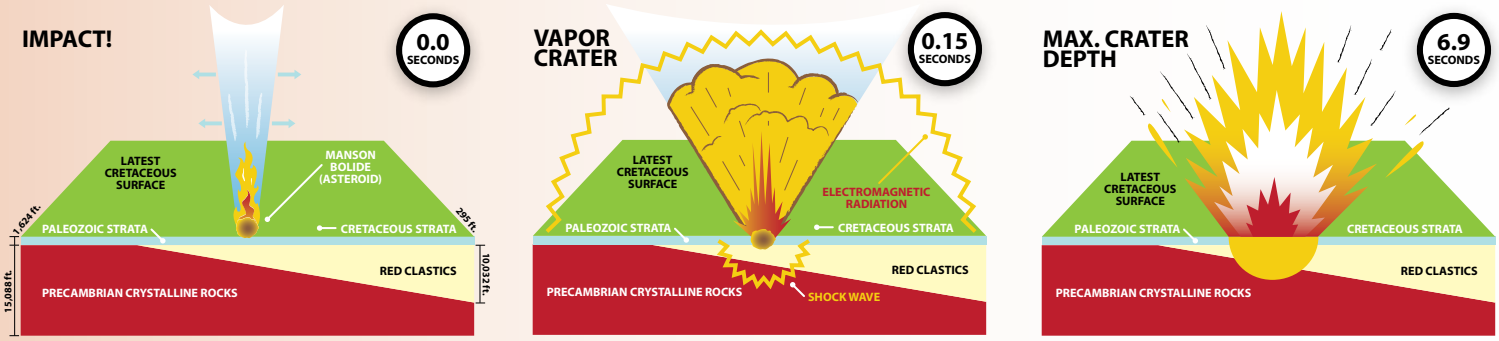
Earlier in his office, Anderson let me handle one of the most spectacular of these, the Marion Meteorite. In 1847 it blazed across the sky right over Iowa City, then the state capital, on the same day that the governor signed the proclamation declaring the University of Iowa. Turning the thing over in my hands, it felt like meeting E.T. This nearly black object with its deeply pockmarked surface worn smooth by the intense, melting heat of friction as it streaked through the sky was, not so very long ago, a neighbor of Mars and Jupiter. Composed largely of iron, it felt oddly heavy, about the size of a Nerf football but weighing as much as a larger rock.

The Manson Meteorite was more like 1.5 miles in diameter. It probably weighed about 12 trillion tons. When it landed, it was traveling about 45,000 miles per hour.

BOOM!

"Here it is," Anderson says, emerging from the lumber-strewn aisle at the core shed with the box he wanted. He opens it to reveal the desired Phanerozoic clast breccia. The rock samples are cylindrical, about two inches in diameter, and have been sawed in half lengthwise to reveal a nice, readable flat surface. Breccia are rocks composed of angular rock fragments. Clast means something smashed up, as in "iconoclast," or one who shatters an icon. And Phanerozoic refers to the long period of geological history that leads up to the present, in which living creatures inhabit the Earth.

In other words, the samples we're looking at were formed by an event so powerful, it shattered the very bedrock into pieces, some the size of pinheads, hurled the fragments for miles around to be mixed with other rocks of different vintages, and liquified the earth into a cauldron of molten rock wider than an Iowa county. The ensuing soup hardened and then waited patiently a few



tens of millions of years for Anderson and his colleagues to extract and interpret these stony rods of prehistory.

"This is from up in the meltrock area," Anderson says, picking up two samples, clanging them together, and enjoying the nice, ringy sound they make. He points out some lighter areas floating around among the dark ones. "These white blobs? That's what melted and recrystalized."

To me, these are white blobs. To Anderson, they read as clearly as a letter only he can decode. "We are white blobs, Ray," they say. "And as you well know, we were put here by the only force on earth that could possibly have placed us exactly where you found us: a giant meteorite."

A few days later, Anderson and I climb into the Iowa Geological Survey government-issue SUV and make a pilgrimage to the place that meteorite landed.

I would like to report that we drove up the side of a ridge, then gazed down from the lip of it into the vast bowl of the Manson crater. Unfortunately, there is no visible crater on the surface. It's deep underground. Thousands of years ago, this 23-mile-wide crater was buried by glaciers beneath hundreds of feet of fine mineral material called glacial till. People have been finding small clues to its existence for years. In the 1920s, when people drilled wells in the area, they found bizarre results. They had to drill much deeper than expected before hitting water. Along they way, they hit granites and gneisses normally found thousands of feet below the surface. When they did hit water it was inexplicably pure, much softer than from wells only a few miles away. Some children who drank only Manson water growing up developed strangely brownish teeth from high fluoride levels. Something had happened long ago that busted up the ground very deeply, leaving pieces of it very far from where they were supposed to be. Only in recent history did anyone realize it was a meteorite.

When we hit Lizard Creek, Anderson pulls over to the side of the road. Here lay meteorite signs.

"I'll put on my official geologizing tool here," Anderson says as he straps on a web belt with a holster from which hangs a hammer with a long, curving claw. You wouldn't want to walk all the way down the creek bed without something to bang rocks with.

According to an old annual report written a couple of generations ago, geologists passed this spot and noticed something odd. Where the earth was revealed by the erosion of the creek, they saw some kinds of rock that by rights should have been buried hundreds of feet below the surface but had been pushed upward by some mysterious force.

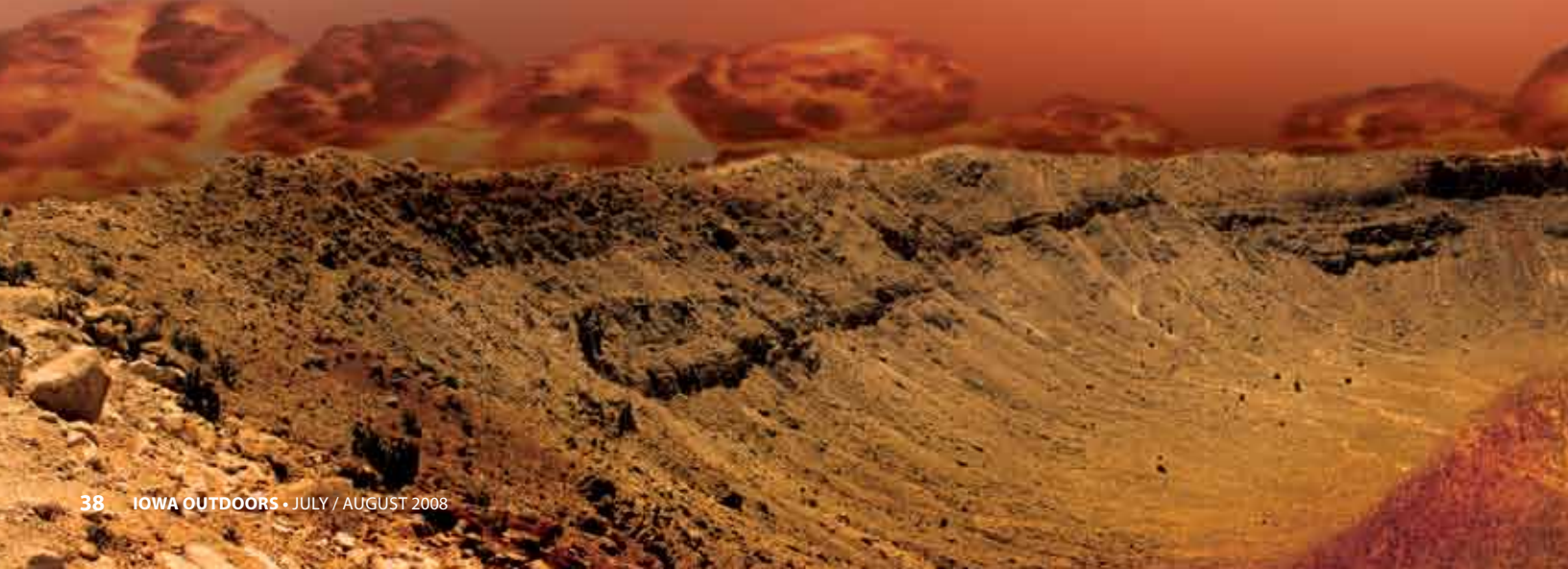
"The old report said it was near the bridge," Anderson says as we begin to clamber downward, through burr oaks and sumac, to the creek below.

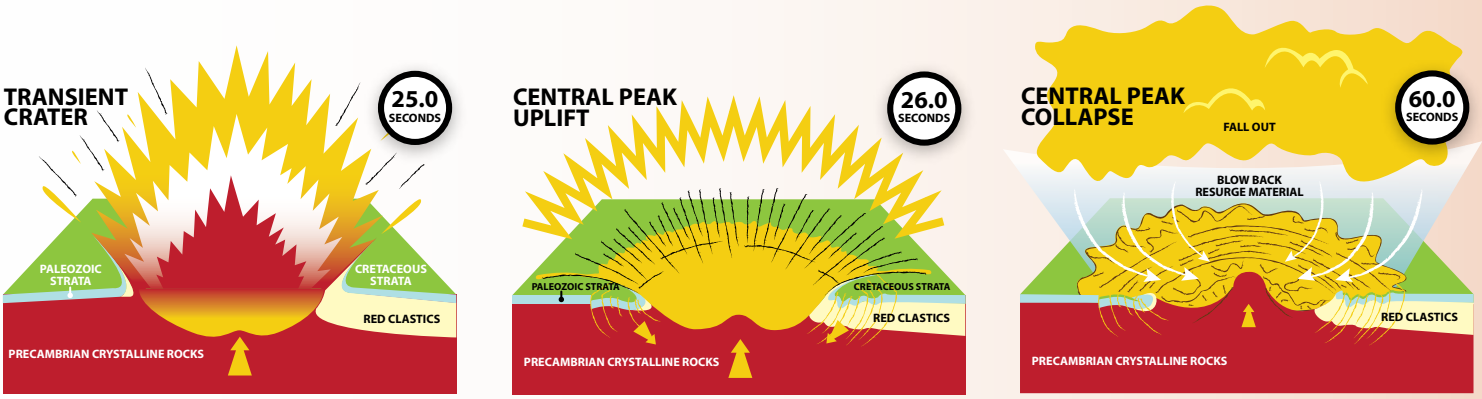
"This is the only thing around to tell you that there's something weird around here," Anderson says. "Why is that Cretaceous rock here? We only know that because those old geologists were such great observers. They told us where to look."

Standing on a sand bar just at water level, he crouches low to examine the wall of the creek bed, then starts to claw at the clayey soil with his hammer.

"What do you know?" he says. "This is an exposure.

ILLUSTRATION BY STUDIO Z – ORIGINALLY DESIGNED BY DR. RAY ANDERSON, IOWA GEOLOGICAL SURVEY





A new one." The river has cut a fresh surface of rock and, with obvious excitement, Anderson knocks a piece of it from the wall. "This is material that was deposited by the Cretaceous seaway when it covered Iowa. It's about 100 million years old."

Anderson hands me the rock to take home, my one souvenir of the meteorite. It's flat, about an inch think. The edges, where they are broken off and exposed, are gray. The top and bottom are yellowish brown, like a thick sandwich in very thin bread. Later at home, my new Cretaceous paperweight would take a place of pride on my writing desk.

As we drive closer to Manson, we're entering the perimeter of the impact structure. We are now inside the crater, although you couldn't tell from looking.

Anderson takes me along a road that nearly bisects the crater through the center. This is where the geologists did their work to confirm the existence of the crater far below the surface. Along this road, Anderson and colleagues drilled a series of holes and pulled core samples from deep below the surface, including the samples he showed me at the rock library. The samples reveal what's going on below the surface in one spot. Put together, they form a sort of interrupted portrait of the underground landscape, like looking at a picture through a series of slits. It's enough information to recognize the picture, but with big gaps.

The gaps were filled by a 1986 petroleum exploration survey. Large seismic trucks sent sound waves deep into the earth and recorded the reflected waves, to get a profile of the rock formations below. It was like getting an ultrasound picture of the crater below the surface. True to the predicted models, the picture that emerged looked something like a crater, with a volcano rising up in the middle.

As we look out through the windshield, all we can see is farm fields.

"Ah, the old scenic Manson Impact Structure," Anderson chuckles, and drives us into town. "Population 1,044" says the sign outside of Manson.

"It's really 1,983 as of the last census," corrects Ann Schlapkohl, director of Manson Public Library.

There is no tourist bureau in Manson, and only now are a few citizens working to put together a historical society. So when people come to look for signs of the meteorite, Schlapkohl is the person they see. And they do come.

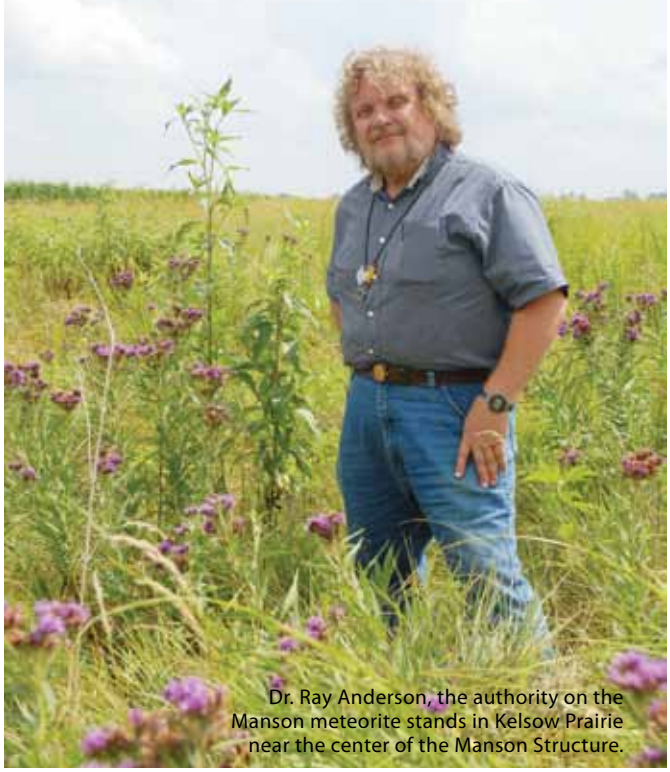
"We had a gentleman write a letter from California, doing a research project, asking did we have an extra piece of the meteorite we could send him?" Schlapkohl says with a smile.

Asking for a piece of the meteorite is a bit like asking for a breath of the carbon dioxide exhaled by a dinosaur.

When a meteorite of this size strikes the earth, the force of the impact creates an explosion so powerful, the meteorite itself is instantly vaporized. Small meteorites leave a trail on the ground; as they descend at an angle, they burrow into the earth and leave a sort of wake. Huge meteorites like Manson don't leave a trail. They behave less like a bullet and more like a bomb. No matter how steep the angle of their descent, when they hit they explode with equal force up, down, and in all directions.

About a tenth of a second after a Manson-sized meteorite hits, a "vapor crater" about two miles across

The impact is the second largest, intact crater in the U.S. Below ground, no remains of the 1.2 mile diameter meteorite exist—it vaporized upon impact. "The meteor story is always fun to tell," says Anderson. "Giant meteors, explosions and dead dinosaurs—you can't go wrong." Once considered a cause of dinosaur extinction, the Manson Impact occurred 8-9 million years too soon. A larger impact in the Yucatan—caused by a meteorite five times the size of Manson's—is now linked to dinosaur extinction. The Manson Impact killed animal life as far as 650 miles away.



Dr. Ray Anderson, the authority on the Manson meteorite stands in Kelsow Prairie near the center of the Manson Structure.

and a mile deep forms, essentially having evaporated a hole in the earth. By about half a second, the earth liquefied in a circle about 3.5 miles across and nearly two miles deep. After seven seconds, the crater is three miles deep and six miles across. Material ejected from this hole blasts upward and outward, widening the crater further. Ejecta from the Manson meteorite has been identified as far away as South Dakota. The molten earth swells up at the crater edges, pressing upward and peeling rock layers from the inside of the crater, forcing the solid surface around it to rise up and fold over onto itself.

The rock at the crater center is so liquid it begins to behave like a pool when a drop of water falls into it. The uplifted edges begin to sink back downward. This causes the center of the crater to rise up. In the case of water, there is an instant when a perfectly round drop of water rises up above the surface, suspended over the center of the circle before falling back down. In the case of rock, as the energy dissipates, the liquid hardens and leaves a rocky peak in the center of the crater. At Manson, below land surface, there remains that rocky peak, which early geologists mistook for a prehistoric volcano.

And oh yes, Manson was also at the bottom of a shallow sea at that time. So along with pulverizing the seabed, the Manson meteorite also pushed the waters back. A few minutes later, all that water rushed back into the center, carrying mud and rocks the size of buildings.

The crater lay for millions of years until glaciers, which steamrolled over Iowa and made most of the state as flat as it is, covered nearly every last trace of it for thousands of years.

So no, Schlapkohl does not have an extra piece of meteorite to send the gentleman in California.

What she does have, for the frequent curiosity seekers, is a box of core samples like the ones Anderson showed me. And in a public park right near the library, there is a model crater dug into the earth, about 30 feet across. In the center stands a tower of rocks about three feet tall, representing the underground peak at the center of the real crater.

According to Schlapkohl, some are disappointed when they come to see the crater and find only farmland.

"Some people say, 'Oh, I've been to the one in Arizona. They've got a gift shop there.'"

For those dead set on owning a souvenir, there is one option. The U-Haul company decorates their rental vans with scenes of the 50 states, part of their Venture Across America campaign. The image they chose to represent Iowa is that of Manson, with its giant meteorite about to strike. For about 10 dollars plus shipping, you can order a Manson Meteorite t-shirt from U-Haul, complete with a complicated mathematical equation provided by Anderson.

At last, we reach the Kalsow Prairie, a small, fenced-in patch of native prairie situated in the southeast corner of Pocahontas County, just near the Calhoun County line. Anderson stops the car and we step out, wading into the native grasses.

"This is about the closest point to the exact point of impact," Anderson says.

Across the flat horizon, the sun glints off a metal barn roof. Heat rising up from the earth makes the horizon shimmer. Prairie butterflies flit past. Looking out over this scene of serene natural beauty, it's hard to imagine this spot was once the site of an event of such unimaginable destructive power. How big was the blast?

"Ten times all the nuclear weapons on Earth at the time of the cold war," Anderson says. "Pile them all up at Kalsow Prairie and set them off." If it struck the same place today, everything in the state of Iowa would be incinerated in a cloud of flames, and most people in a circle stretching approximately from Detroit to Denver would be killed.

Scientists believe that a meteorite impact caused the extinction of dinosaurs, along with about 70 percent of all land species and 90 percent of all ocean species. For a while, the Manson Meteorite was a strong contender for the title of dinosaur killer. But it turns out that the timing was wrong. The great dinosaur extinction happened about 65 million years ago, and Manson struck somewhat earlier, about 74 million years ago. Another meteorite, which struck in Mexico's Yucatan, is now believed to have brought about the extinction of T-Rex and stegosaurus.

In fact there are not one, not two, but many such impact structures on the earth and under the oceans. A sobering thought. According to an on-going study of Earth-crossing asteroids, a meteorite the size of Manson hits our planet on a land mass about every 3.5 million years. There is no way to predict the arrival of another such catastrophe. By the time it was detected, it would be over.

Standing waist-deep in prairie grasses, I look straight up. Then, chastened, I let my eye drop back down at the butterflies. Better not to think about it.

Anderson and his colleagues continue to study the Manson rocks and learn more about the cataclysmic event that happened here those millions of years ago.

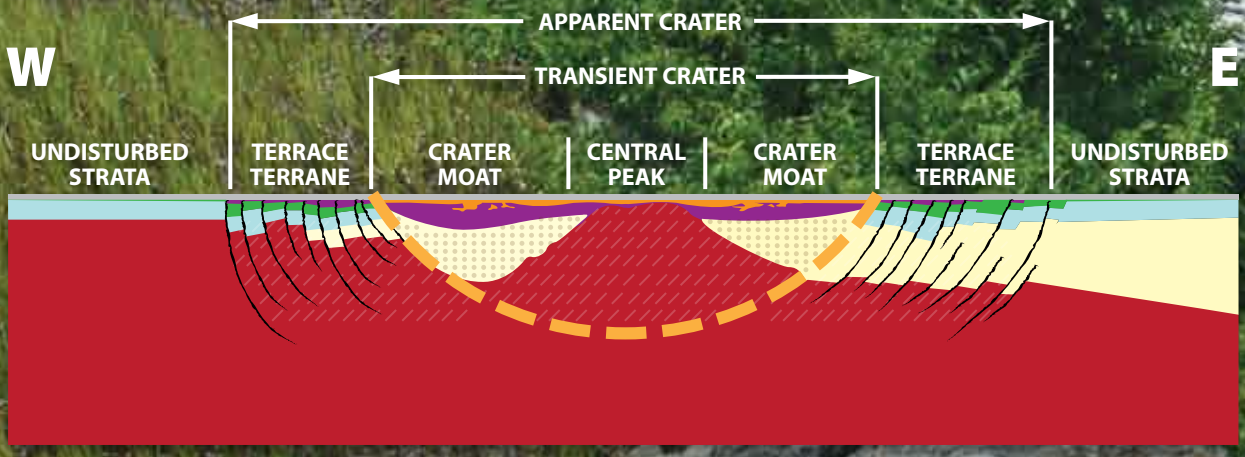
"It's one of the best understood impact structures in the world," Anderson says. "And there are zillions of things we don't know about it."

ILLUSTRATION BY STUDIO Z

Lizard Creek,
Webster County

RINGS OF DESTRUCTION

MANSON IMPACT STRUCTURE



- GLACIAL DRIFT
- FALL-BACK
- DEBRIS FLOW
- TRANSPORTED, BRECCIATED STRATA
- BRECCIATED CRYSTALLINE ROCK
- CRETACEOUS ROCKS
- PALEOZOIC STRATA
- RED CLASTIC ROCKS
- GRANITE BASEMENT
- TRANSIENT CRATER

ILLUSTRATIONS BY STUDIO Z – MORPHOLOGY ORIGINALLY DESIGNED BY DR. RAY ANDERSON, IOWA GEOLOGICAL SURVEY

BACKGROUND PHOTO—An early quarry near Gilmore City just outside the crater rim. Used for concrete, the valuable limestone would not be easily reached without help from outer space. The meteor strike pushed the rock up some 200 feet, making quarrying less costly.

In the early 1990s, geologists theorized the meteorite impact played a role in the dinosaur extinction 65 million years ago. Twelve core samples totaling over 4,000 feet were studied along with other crater data by scientists throughout the U.S. and other nations. They identified the structure as a complex crater that includes an outermost terrace terrane of down-dropped blocks, an inner central peak, and a crater moat in between (diagram, below left). But they learned the impact occurred nine million years before dinosaur extinction, so the Manson meteorite was not the demise of dinosaurs. Today there are no visible signs of the crater—it lays 100 to 300 feet below the surface.

Learn more about famous Iowa meteorites online at: www.igsb.uiowa.edu/browse.htm#meteor

CRATER SPANS 23 MILES AND FOUR-COUNTIES